

FIGURE 1

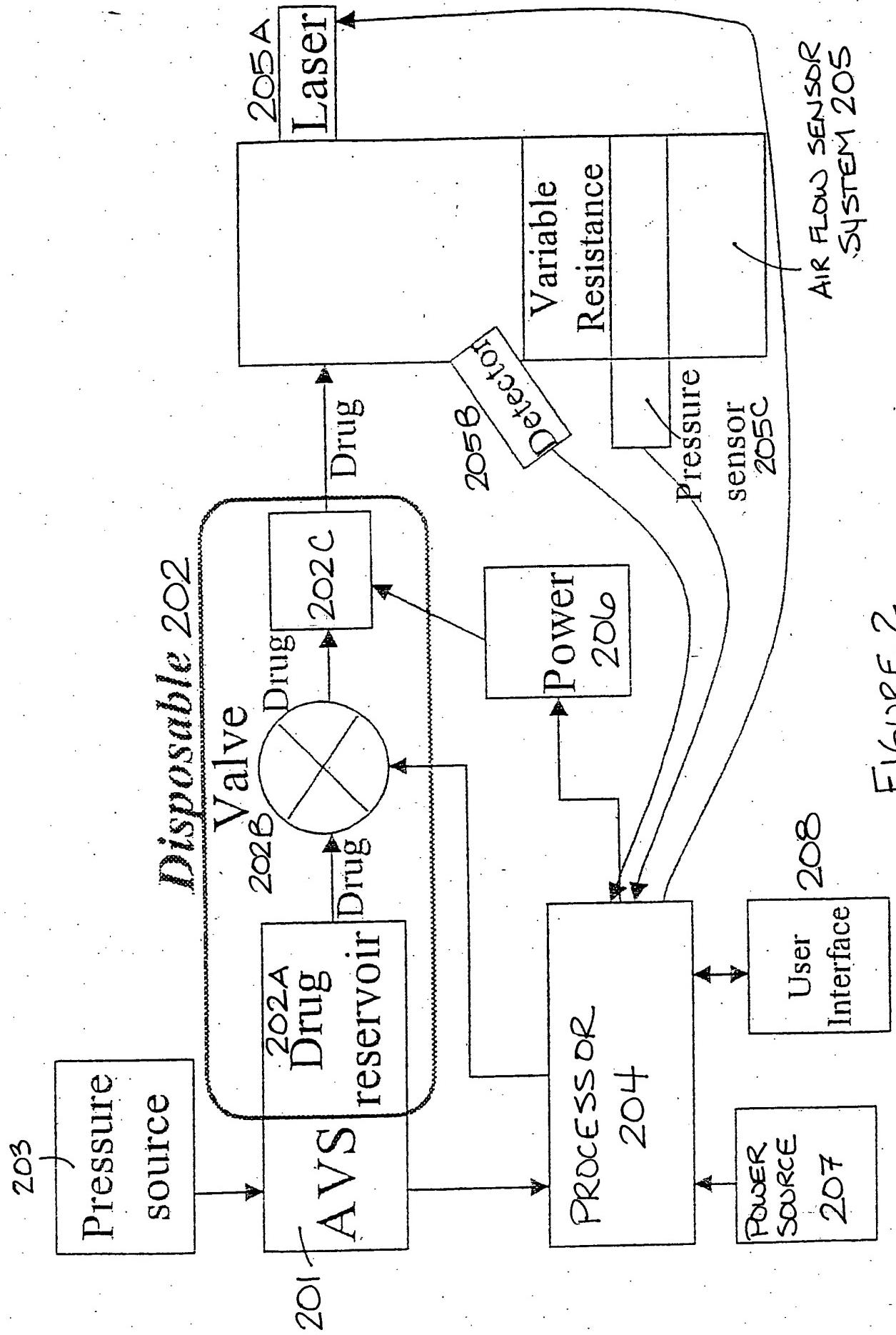


FIGURE 2

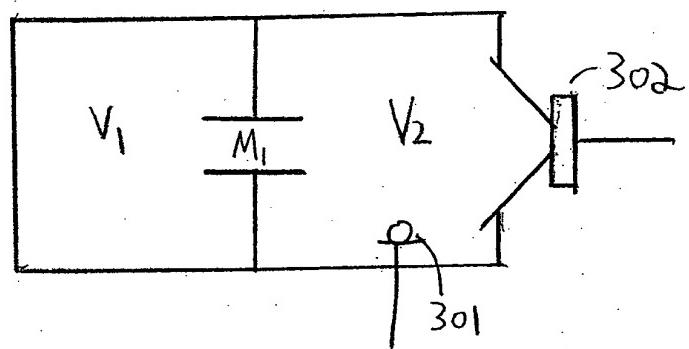
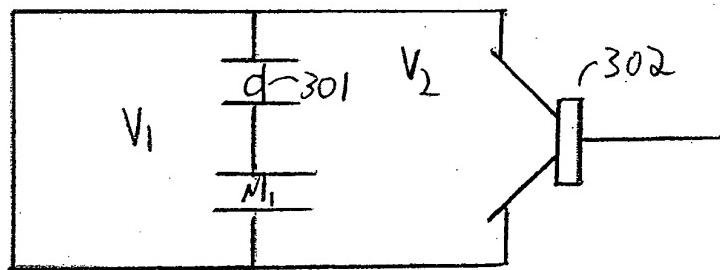
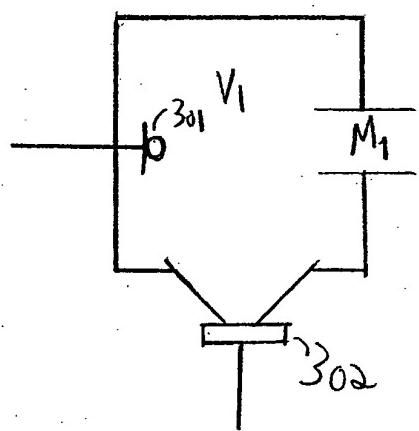


Figure 3

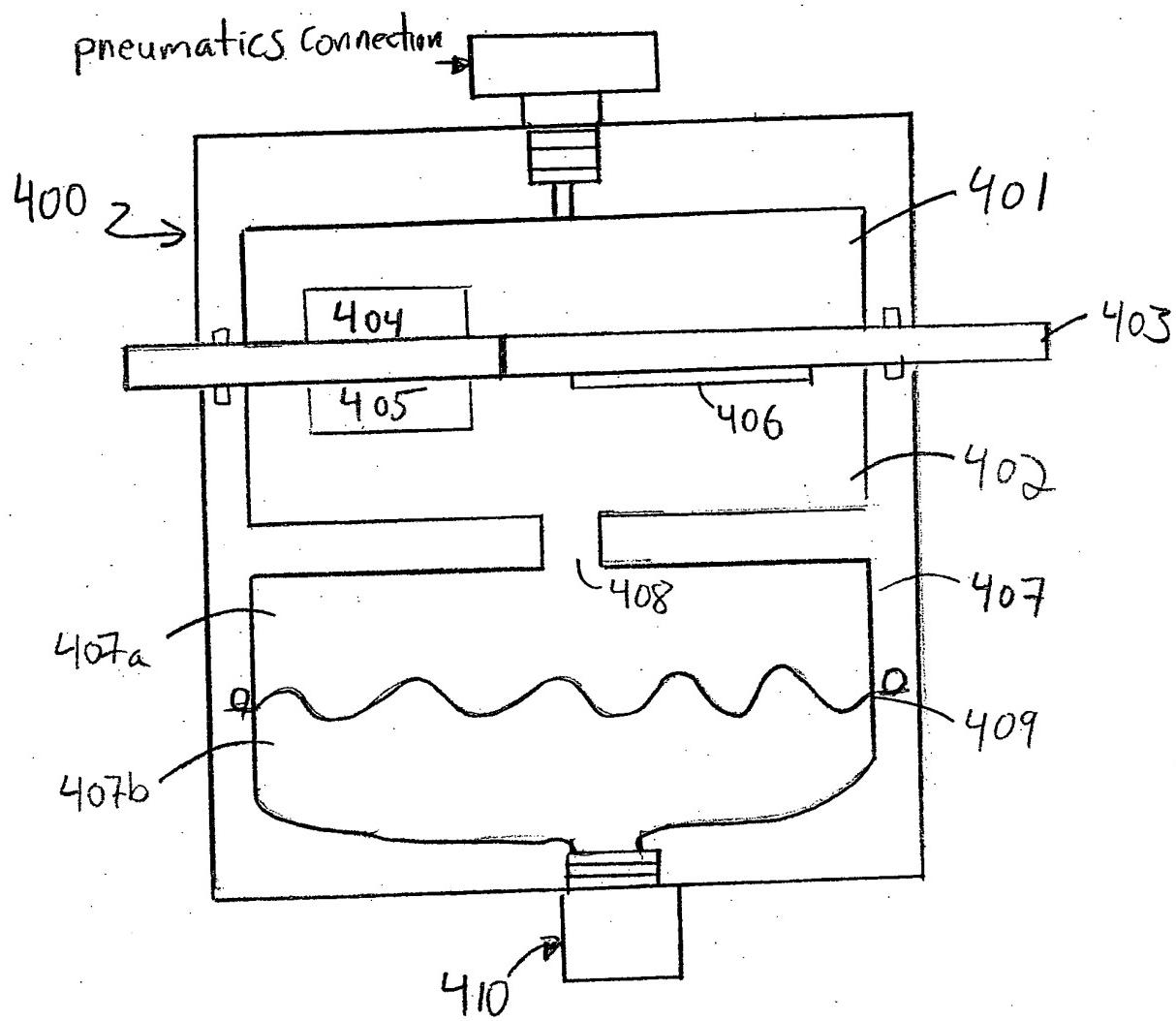
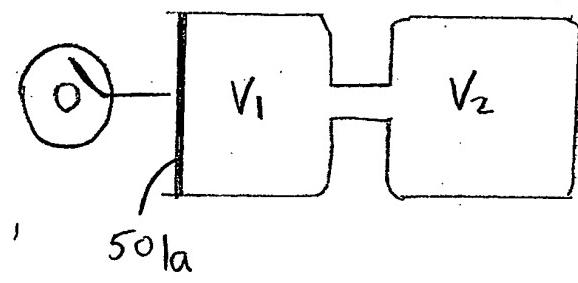
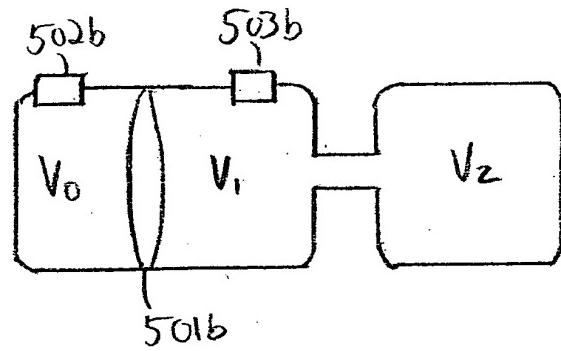


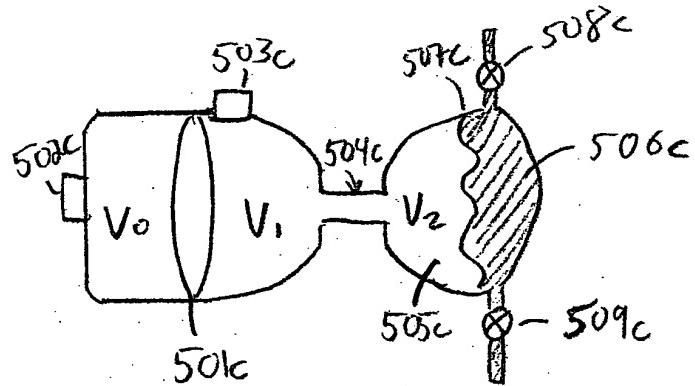
Figure 4



$5a$



$5b$



$5c$

Figure 5

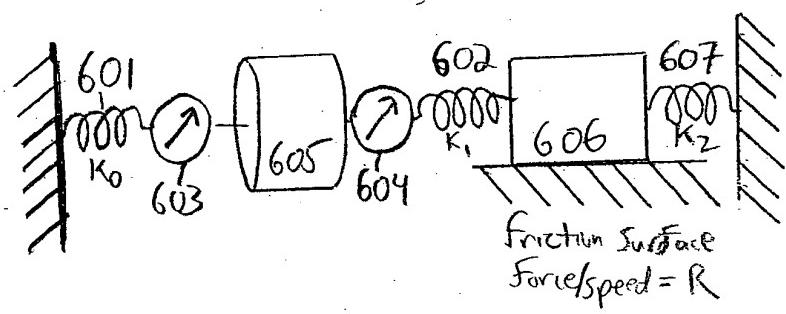


Figure 6

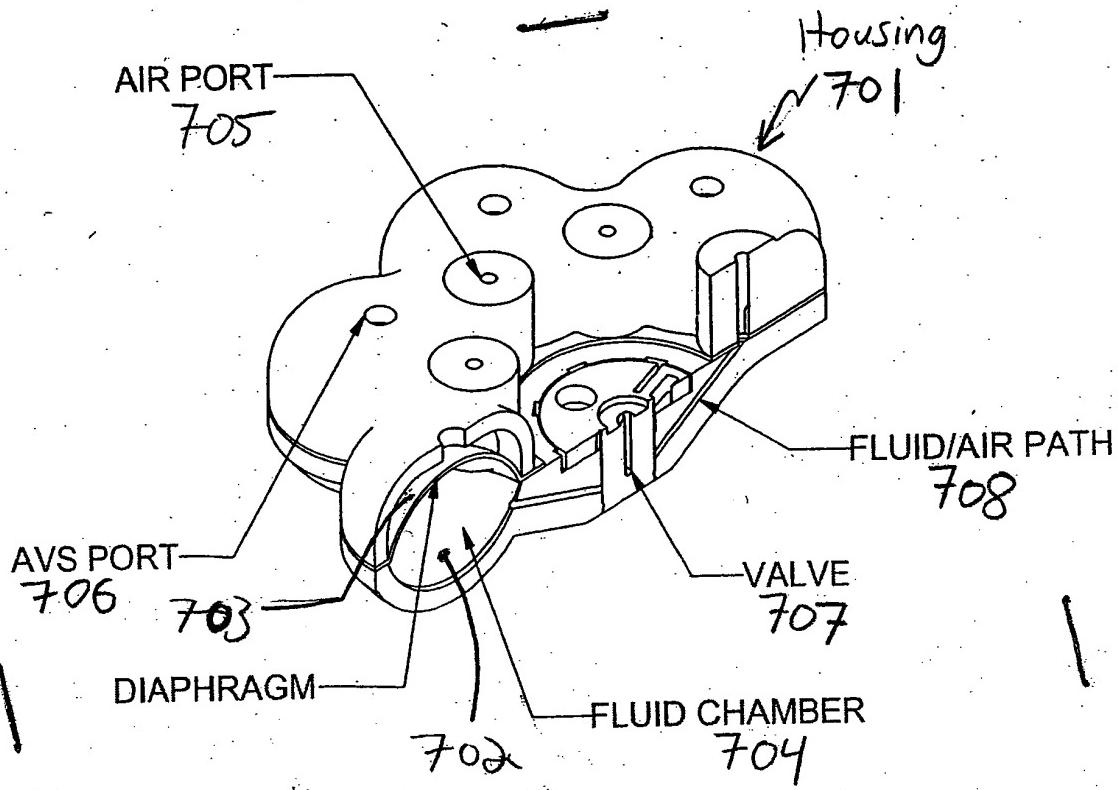


Figure 7

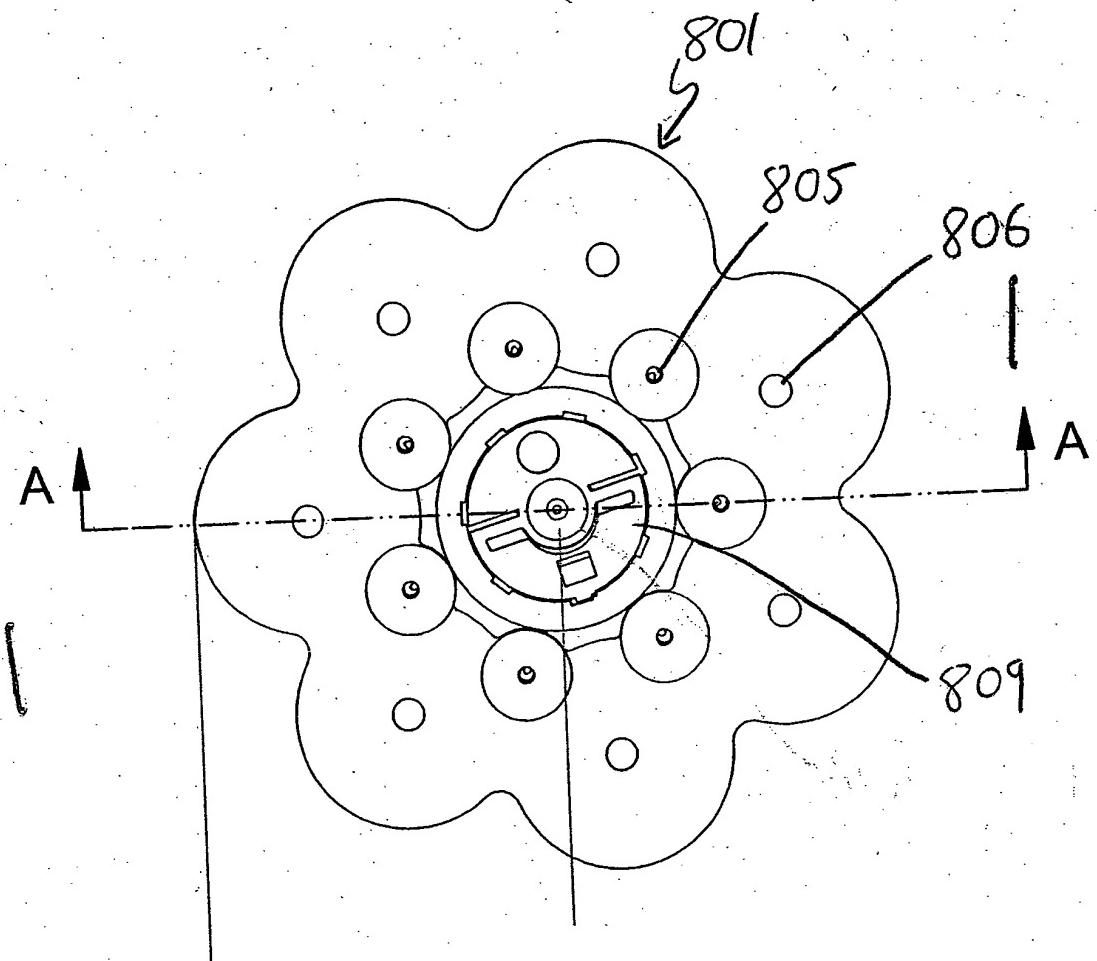


Figure 8

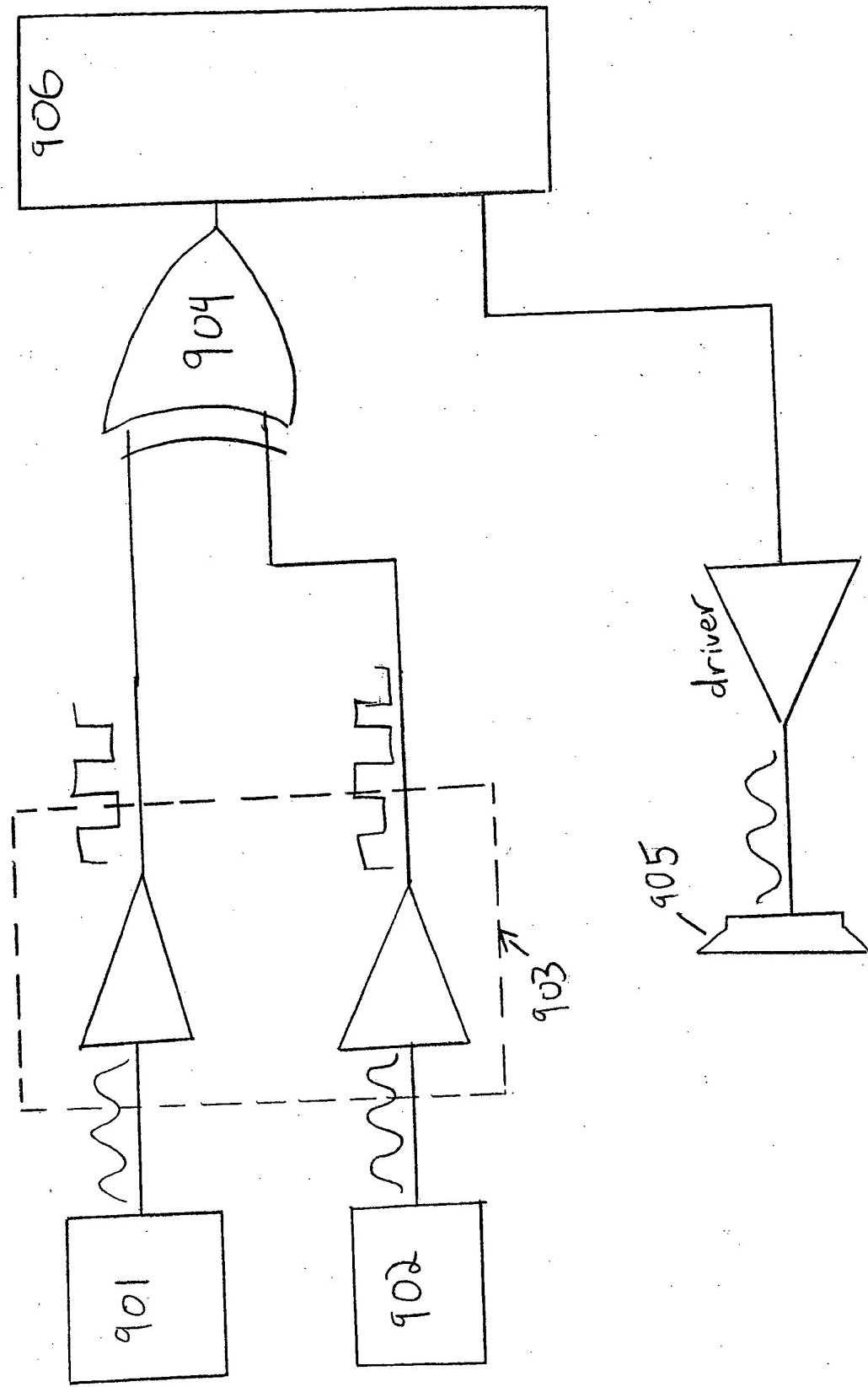


Figure 9

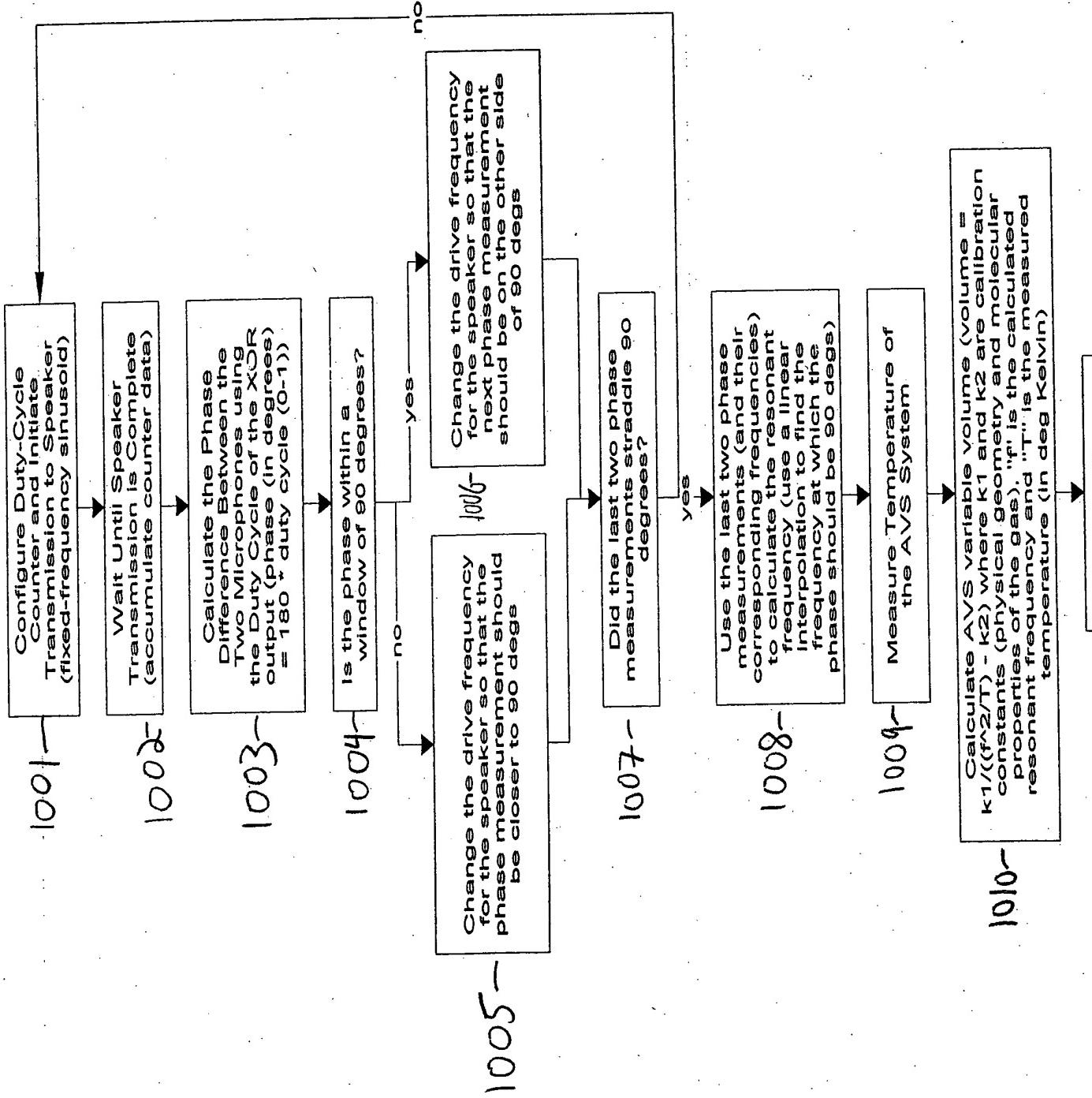
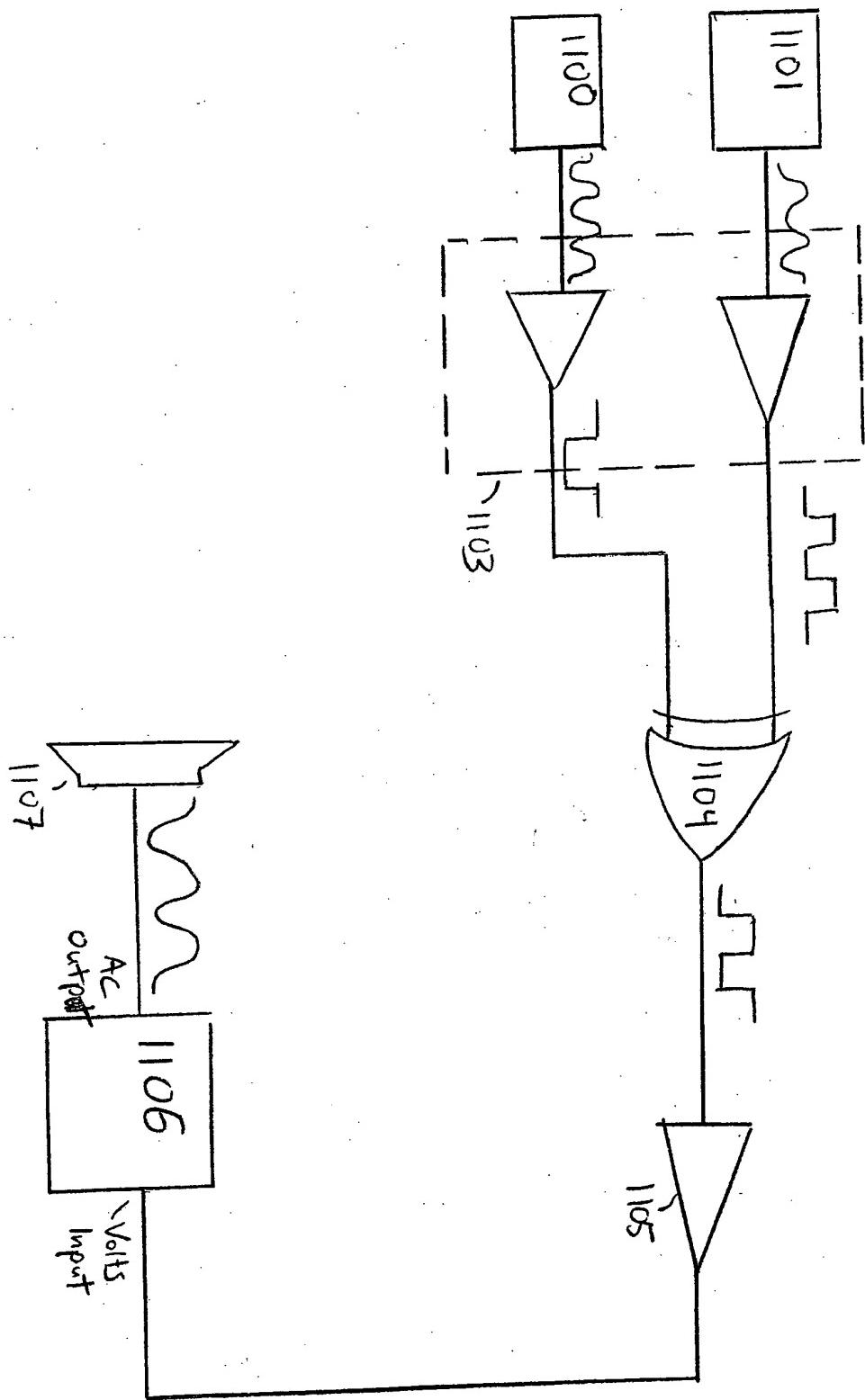


Figure 10

Figure 11



Configure Frequency
Measurement Counter

(using a high-speed timer to
measure the frequency
output from the VCO or
measured by the
microphones)

Measure Temperature of
the AVS System

-|202

Calculate AVS variable volume (volume =
 $k_1 / ((f^2 T) - k_2)$ where k_1 and k_2 are calibration
constants (physical geometry and molecular
properties of the gas), " f " is the calculated
resonant frequency and "T" is the measured
temperature (in deg Kelvin))

-|203

DONE

FIGURE 12

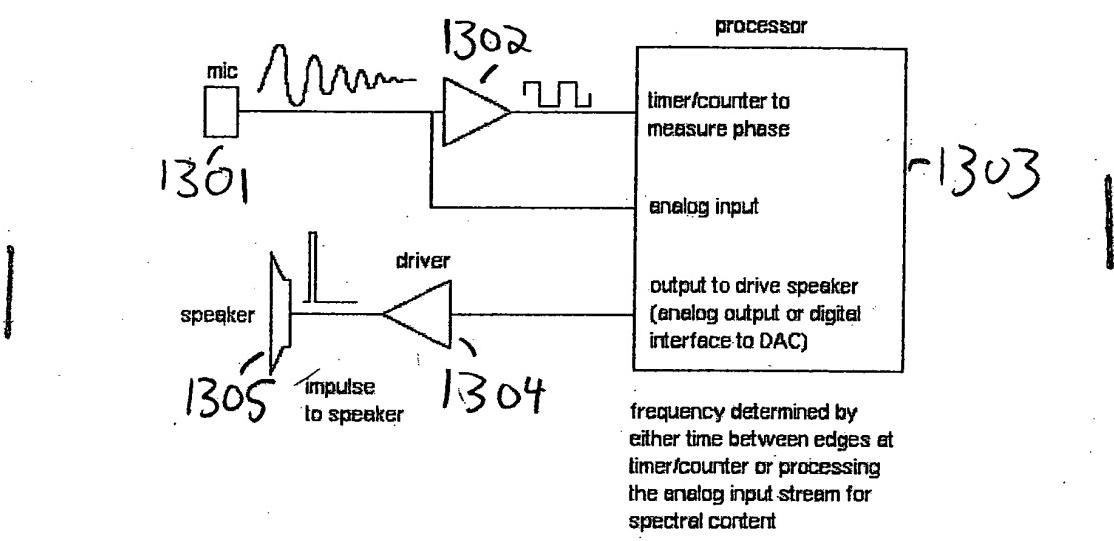


Figure 13

Configure Frequency Measurement Hardware
(using either a high-speed timer to measure the
time differences between the microphone's
zero-crossing or an ADC with high-frequency
sampling and algorithms to examine the
spectral content of the output)

-1401

Send an Impulse to the
Speaker

-1402

Record data as the
microphone's output reacts
to the second-order ringing
of the resonator and
finishes decaying

-1403

Measure the resonant frequency of
the AVS using the microphone's
output (frequency of an underdamped
2nd-order system)

-1404

Measure Temperature of
the AVS System

-1405

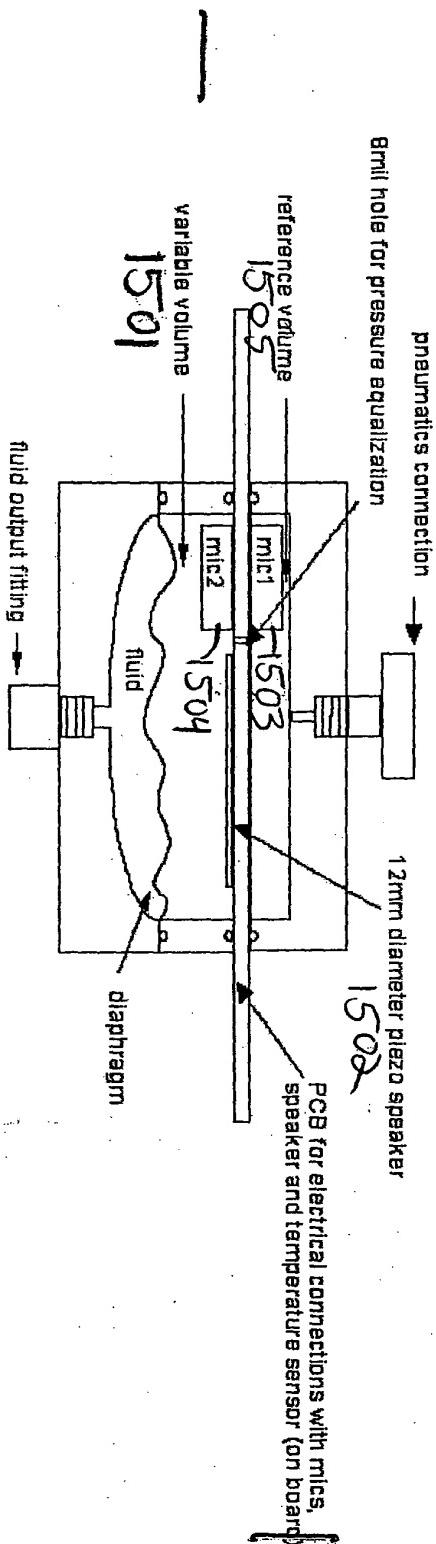
Calculate AVS variable volume (volume =
 $k_1 / ((f^2/T) - k_2)$ where k_1 and k_2 are calibration
constants (physical geometry and molecular
properties of the gas), " f " is the calculated
resonant frequency and " T " is the measured
temperature (in deg Kelvin)

-1406

DONE

Figure 14

Figure 15



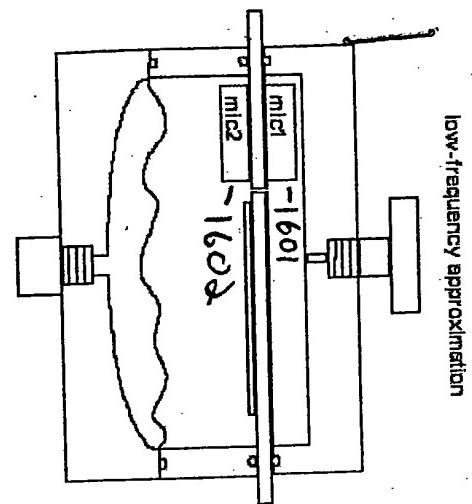


Figure 16

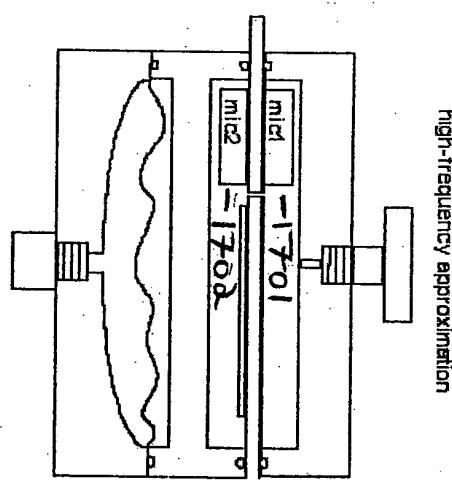


Figure 17

set the speaker into sinusoidal oscillations at a fixed frequency (if an acoustic port is present, use a frequency << the resonant frequency of the AVS)

- |80|

measure the amplitudes output from each of the two microphones (and, if desired, confirm that the outputs are 180 degs out of phase)

- |802

Calculate the AVS variable volume (= reference volume * (ref mic amplitude/front mic amplitude))

DONE

- |803

(if desired) Cycle through multiple frequencies to confirm the volume measurement (should be independent of frequency, presence of air bubbles within the variable fluid volume or other "acoustic leaks" or mic/ electronics errors may be detected)

(if desired and using AVS) Perform a volume measurement (with amplitude ratio technique) using a frequency \gg resonant frequency of AVS (should be equal to the fixed volume and independent of the variable volume). This is a good confirmation of system performance and may be used to assist in air bubble detection or compensation for microphone sensitivity drift or electronics errors.

Figure 18